SYNCHRONICITY AND SIMILARITY OF BUSINESS CYCLES; CROATIA VIS À VIS NEW EMU COUNTRIES

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ABSTRACT

The introduction of the euro for Croatian citizens meant the abandonment of the deutsche mark, a reliable currency, which had been used for a long time for comparison purposes and savings. Today, Croatia is a small, opened, indebted and highly euroised country, in which frequently mentioned introduction of euro is seen as a solution that could improve country's economic position. The question of a common monetary policy is closely related to the issue of business cycle coherence between the members of such an area. By analyzing two measures of business cycle coherence, namely synchronicity and similarity, between Croatia and new EMU members, we want to reconcile with vast empirical evidence supporting the hypothesis that monetary integration process results from a greater business cycle convergence and leads to an optimal currency area which finally leads to greater economic welfare in each of the member countries. Estimations are based on deviation cycle approach. Results in general indicate relatively similar cycle dynamics across the observed variables, suggesting that Croatia satisfies this selective criterion for its inclusion into the monetary union. Nonetheless, monetary integration is far more complicated issue, hence it requires further scientific verification and conceptualization.

Key words:
Business cycle coherence, Deviation cycle analysis, HP filter, Chow test, Croatia, EMU

1. INTRODUCTION

Reversals in business cycles raise a question whether a group of countries can achieve macroeconomic stability and/or economic growth by coordinating its economic policies. Common shocks imply the co-movement of economic activity across the countries, within a phase of a business cycle, which in turn is more likely if their economic structures are similar. For example, countries with more correlated and synchronized business cycles are more likely to 'bear the fruit' of any economic bond, especially of a monetary union for they are less sensitive to asymmetric shocks, hence the cost associated with the central monetary policy is lower. As Stanišić (2013) put it well, a strong degree of business cycle synchronization across monetary union reduces the cost of giving up an independent exchange rate and monetary policy, especially when alternative adjustment mechanisms are unable to absorb the impact of asymmetrical shocks across countries because of price and wage rigidities and insufficient labor mobility. Business cycle synchronization is therefore an important aspect of the readiness of potential members outside the eurozone to enter the monetary union. Recent economic turmoil reminded the EU that adequate degree of cross-country business cycle coherence is important for monetary unions to be viable in the long-run, as one can argue that the current degree of eurozone economic integration is too low for viable currency union (Ahmed, Chaudhry and Straetmans, 2015).

The aim of this paper is to evaluate the synchronization process between the new EMU (European Monetary Union) members and Croatia, as reflected in the degree of coherence between the countries cycles. By analyzing business cycle aspects of the Croatian economy, we are in fact addressing key macroeconomic issues that are or might be crucial for the economic stability and a sustainable progress. Considering different roles of fiscal and monetary policies within decision-making dilemma, each economic problem should be approached differently depending upon the specific cycle characteristics of the country. By estimating two different measures of business cycle coherence between Croatia and new EMU members, we want to reconcile with vast empirical evidence supporting the hypothesis that monetary integration process arises from greater business cycle convergence and leads to an optimal currency area (OPA) which finally leads to greater economic welfare in each of the member countries. We opted for deviation cycle analysis, whereas cyclical characteristics of the variables are obtained through the HP filter. By applying the methodology proposed by Mink et al. (2012) we have calculated two measures of coherence, i.e. synchronicity and similarity in order to capture both co-movement and relative amplitude of the Croatian macroeconomic variables *vis* à *vis* new EMU member countries.

Section 2 provides theoretical background and empirical literature. Section 3 gives a full perspective to the analytical part by explaining used methodology and data whereas Section 4 evaluates the results through brief discussion. Section 5 offers some concluding remarks.

2. THEORETICAL FRAMEWORK AND STYLIZED FACTS

2.1. Theoretical background

Before we get any further into the subject let us clarify some basic terminology. Broadly used term business cycle synchronization, as an indicator of the degree of co-movements of the fluctuations across countries and time, is a mere coherence measure. Hence, most of the scholars use term synchronization to explain coherence between the cyclical patterns of growth between the countries. We will follow their example in this theoretical part, though in the empirical section we will make a distinction, namely methodological, distinguishing two coherence measures (see *Section 3*).

In their paper, Crowley and Schultz (2010) pointed out two important reasons why synchronicity in movement of economic growth rates is economically relevant: (1) the more globalize world becomes, the more likely is that trade and financial flows will cause great synchronization in growth rates between countries which could result in creation of 'the international business cycle' and (2) for countries that use the same currency (such as EMU) similar movements in economic growth could either indicate (i) *ex ante*, the suitability for adopting same economic policy (for example monetary policy in OPA theory for EMU) or (ii) *ex post*, the fact that that (monetary) policy has been a major factor in achieving similar patterns of growth (an interesting debate on the relationship between the business cycle synchronization and growth perspectives is provided by Škare and Tomić (2015)). Since the notion of synchronization is frequently related to the question of optimum currency areas i.e. OPA theory, as it has come to be recognized as a prerequisite for any higher level of economic integration. The benefits from a common currency are seen in the reduction of transaction costs and predictability of exchange rates as higher levels of integration are associated with larger benefits for the member countries. On the other hand, the costs of such cohesion are related to the loss of monetary policy as a stabilizing tool. To the extent that member countries are *de facto* faced with common aggregate (external) shocks, the costs of losing independence of monetary policy may not be important.

Issue of synchronization is important from a policy point of view. If the business cycle coherence in the monetary union is high and/or increasing, there will be no tension between the member countries. However, a reverse situation could lead to a destabilization of a monetary union as it can further lead to more volatile reactions to external shocks and similar transmission of country-specific shocks through various channels such as international trade and financial assets (Stanišić, 2013). For example, persistent cross-border swings in financial markets can be potentially destabilizing for EMU and in the end also for the real economic developments, so Ahmed, Chaudhry and Straetmans (2015) suggest that a proper monitoring of (financial)

synchronization by regulatory bodies and policy makers is desirable. Additionally, the autonomy of fiscal policy on national levels is a major offset to the synchronization process, as it counteracts the efforts of the European Central bank in its impact on the whole EU economy. Nonetheless, higher synchronicity implies that member countries will increasingly need monetary policy moves in the same direction to achieve common goal. But as Wälti (2009) explained, this is a necessary and not a sufficient condition for a harmonious monetary union. Strong synchronicity does not mean that all countries demand policy moves of the same magnitude. The amplitude of business cycles may still differ across countries, so that even if synchronicity is perfect, 'one size still does not fit all' paradigm is a suitable conclusion. Most of the studies use correlation coefficients in the analyses of business cycle coherence, however since they can ambiguously interpret these two cycle characteristics, they are not informative on the suitability of the common monetary policy in terms of both direction and magnitude of policy moves. This is the argument for the reliance on an alternative approach, i.e. two measurements that imply direction and magnitude in the periods of high and low coherence between the countries.

2.2. Overview of the literature

Academic literature as well as the media press is full of references and studies that emphasize the importance of the synchronization process, even on a global scale. To curtail vast empirical base as to make it easier to comprehend the importance of this topic, we will analyze evidence for cyclical synchronization only for the EU and/or EMU countries (and those issues conceptually related to the topic). But first, we must inquire into the methodological prospect and significance of these studies. Namely, we find a variety of methodologies that have intrinsically different approach to the analysis of business cycle synchronization, regardless of mean of the identification of cyclical movements (parametric or non-parametric methods). This variety is seen through the broadness of methods used within different studies, ranging from simple to asymmetric to dynamic correlations between the cyclical series across countries, rolling correlations, different vector regressive models, dynamic factors models, VAR to GARCH models, panel VAR models, GLS regressions, multilevel structural factor models, multivariate logit models, Markow switching models, different concordance measures, spectral analysis, and etc. (interesting systematizations are provided by De Haan, Inklaar and Jong-A-Pin (2008), Škare and Tomić (2015) and Ahmed, Chaudhry and Straetmans (2015)). Here are some of the studies that have addressed business cycle synchronization in the EU or in eurozone.

Fatás (1997) by using data from 1966 to 1992, studied the evolution of business cycle synchronization between the EU countries together with the regions. By calculating employment growth correlation in EU 12, Fatás concluded that correlations were higher in the EMU then before it, however he also identified a fall in

cross-country correlations between the same-country regions. Artis and Zang (1997, 1999) by using different band-pass filters, calculated lead and lag bivariate correlations indicating that cycles have become more group specific after the exchange rate mechanism (ERM). Angeloni and Dedola (1999) analyzed GDP correlations and came to conclusion that there has been a significant rise of the output correlation between Germany and other European countries, particularly in the period from 1993 to 1997. Döpke (1999) made rolling contemporaneous correlations based on a five year moving average for HP detrended data and suggested an increase in correlation between most of EU countries and the eurozone. Harding and Pagan (2001), on the other hand, made correlations and regression on binary series and found relatively low correlations between members countries and euro area. Camacho, Perez-Quiros and Saiz (2006), with three different measures of synchronization, found relatively high linkages across euro countries, but these are prior to the establishment of the monetary union. Next, Woźniak and Paczyński (2007) used the Kalman filter to extract time-varying spectral properties of GDP growth rates within the new member states and the eurozone in order to estimate the coherence between these series. The analysis of individual spectra has confirmed the existence of several common features such as concentration of power in the low business cycle frequency ranges. Montoya and Haan (2007) also analyzed the synchronization of business cycles in the eurozone countries. The authors came to the conclusion that there is a synchronization period between the observed countries, and that its duration decreases in time.

Mink et al. (2007, 2012) exposed a new cycle co-movement measure which allowed them to determine the synchronization of cycles and the differences between their amplitudes. Overall conclusion was based on the fact that the synchronicity and similarity between output gaps of individual countries and the reference fluctuate over time, and often are not higher than would be expected under output gap independence. Van Aarle et al. (2008) came to conclusion that on average business cycle convergence in the euro area has not changed substantially since the introduction of the euro. This result was robust to the measurement of the cycle and to different sample periods. Wälti (2009) by using probit regressions of synchronicity found that although the introduction of the euro has raised the likelihood of business cycle synchronicity, it has not affected the relative amplitude of business cycles.

Afonso and Furceri (2009) evaluated the sectoral synchronization in the EU 27 for the period 1980-2005 and concluded that, in general, some sectors such as industry, building and forestry contribute more to the aggregate output synchronization in comparison to the services sector. Afonso and Sequeira (2010) also noticed very high degree of business cycle synchronization to that of some EU-15 countries. Crowley and Schultz (2010) by measuring topological differences between GDP growth pattern in recurrence plots for individual countries concluded that there are certain periods of time when growth rate synchronicity increased and these appear after 1983 up until roughly 1990, and then again from 1997 through

until 2002. After 2002 synchronicity is only higher against the non-euro area European member countries. Artis, Chouliarakis and Harischandra (2011), conducted a more extensive research involving a larger period and more countries entitled 'Business cycle synchronization since 1880's. This work showed that there exists synchronization between the countries that are geographically related to the EU and those countries that are related by a language factor. They additionally proved that these synchronization processes accelerate between the surveyed countries in a time perspective. Sella et al. (2012) used spectral analysis when observing cycle synchronization for Italy, the Netherlands and the UK. They concluded that there indeed exists the synchronization process between these three countries for the duration (on average) of five years for one cycle. Stanisic (2013) found that Slovenia had one of the highest average correlations of business cycles with the euro area. Antonakakis and Tondl (2014) reassessed that business cycles have become more synchronized in the EU.

2.3. Stylized facts about Croatia

We can also trace some relevant papers in the business cycle (synchronization) literature that considered Croatia as a part of their studies. Šonje and Vrbanc (2000) analyzed similarity measurement of economic trends in Central Europe through business cycle approach. By using HP filter, they came to conclusion about close correlation of cyclical movements in Central Europe with strong correlation of unemployment between Croatia and Germany. Arčabić (2011) investigated business cycle synchronization (by using rolling correlations) and transmission (by using two-variable VAR model) from the EU to Croatia with the results indicating a high degree of synchronization (above 0.9) and an increasing level of synchronization since 2002. Jovančević, Arčabić and Globan (2012) showed that Croatia has been extremely sensitive to economic shocks from abroad and that the intensity of transmission of business cycles has further increased in recent period. Demanuele (2017) analyzed some aspects of coherence measures between Croatia and selected EMU countries and came to conclusion that Croatia still does not satisfies Maastricht criteria, however he found relative similar cyclical movements within this set of countries. Tomić and Stjepanović (2017a) offered conclusion regarding the nature of business cycle synchronization, cyclical regularities, and macroeconomic interdependence by studying the data on the output and related macroeconomic variables for the EU countries with the spectral analysis. They found that in the group of countries, mainly developing ones (including Croatia) we can identify cycle synchronization in the duration of between four and five years. Tomić and Stjepanović (2017b) also analyzed important macroeconomic variables for Croatia for the period from 1997 to 2016 by using spectral analysis. They offered some forecasting assessments that include very pronounced seasonal effects in the variables.

By looking into the period of our investigation, it can safely be said that Croatia, in general, had met some of the convergence criteria. Until joining the EU in 2013, Croatia was satisfying only two criteria; inflation and long-term interest rate criteria. In next two years, Croatia managed to fulfil additional legislation compatibility criteria, but still it did not meet the public finance and ERM membership criteria. The 2016 Convergence Report (2016) concluded that Croatia currently fulfils three out of the five criteria necessary for adopting the euro; the criteria relating to legal compatibility, price stability and long-term interest rates, and does not fulfil the criteria related to public finances or the exchange rate. The problem with public finance criteria is that for 2015 budget deficit to GDP was 3.2% (over max. 3.0%) and debt to GDP ratio was 86.7% (above the limit of 60.%). On the other hand, Croatia is yet to be approved for ERM II membership, therefore it cannot satisfy the exchange rate criteria (even though it satisfied the additional criteria of only 0.3% change in the exchange rate which is below allowed max. off ±15%).

As the EU leaves to the individual countries to calibrate their own path towards the euro and there is no timetable prescribed, it still emphasizes the importance of euro adoption as a medium-term policy anchor for the benefits of the common currency are diverse and can be accomplished on different socio-economic scales (such as stable prices that lead to stable economies, more transparent and competitive market, more trade and travel, better access to capital and etc.). Though we can say that preparation for the eurozone membership is essential for Croatian prosperity, some of the latest developments (such as Brexit and some other announcements for the euro abandonment, Denmark negotiated an opt-out as did the UK, 2008 financial crisis put an enormous strain on the eurozone, especially on some lagging countries such as Portugal, Spain and Greece, the lack of discipline in the whole euro are) shed a new light on this topic. Should Croatia therefore rush towards the euro or adopt a wait and watch policy, becomes an intriguing question.

3. METHODOLOGICAL ISSUES AND THE RESULTS

3.1. Methodology

This paper investigates the degree of business cycle synchronization between the new euro area member countries and Croatia over the period of almost 20 years. Determining the phases of the cycle is not the objective of this paper. We would rather focus on the coherence measurement issue using the periods of high and low coherence between the variables across the reference countries. In order to analyze the business cycle synchronization across a set of European countries, we first computed cross-correlation coefficients between the cyclical component of a set of variables in Croatia and the cyclical component of a set of variables in the euro area i.e. EMU19. Cross-correlation coefficients would reveal us which variables should we use within

the next phase of the research. In the next phase, we have calculated the two mentioned coherence measures, namely synchronicity and similarity, to uncover the extent of business cycle coherence between Croatia and new EMU countries. In the third phase, we have applied the Chow test for structural break across the countries and variables to see if we can also trace an analogy in these developments.

First, in order to evaluate cyclical components of selected macroeconomic variables we have followed the works of Stock and Watson (1998), Agresti and Mojon (2001), and Napoletano, Roventini and Sapio (2005). Though their work was based on Baxter-King filter, instead we have used Hodrick-Prescott (HP) filter that has come to be recognized as standard method for removing long run movements from the time series in the business cycle literature. Furthermore, we tested integration properties of the data to evaluate their methodological possibilities (similar to Benazić and Tomić, 2014). The popularity of the HP filter to detrend a time series is certainly due to the fact that it is easy to estimate and to comprehend. Hodrick and Prescott's (1997) analysis was based on the assumption that time series are presented through cyclical and growth components, so if growth accounting can provide estimates of growth components with errors that are small relative to the cyclical component, computing the cyclical component is just a matter of calculating the difference between the observed value and the growth component. It resulted in creation of the filter that became standard method for removing long run movements from the time series in the business cycle literature. The HP filter focuses at removing a smooth trend τ_t from some given data y_t by solving next minimization problem:

$$\min_t \sum_{t-1} ((y_t - \tau_t)^2 + \lambda((\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}))^2) \quad (1)$$

so the residual y_t - τ_t is then commonly referred to as the business cycle component. This is actually a linear filter that requires previous specification of a parameter known as lambda (λ). Based on the form of the observation (annually, quarterly or monthly) this parameter tunes the smoothness of the trend i.e. penalizes the acceleration in the trend component relative to the cycle component. Many point that the parameter λ does not have an intuitive interpretation for the user and that its choice is consider the main weakness of the HP filter. Non-the-less, HP filter has been applied in a number of relevant studies[1].

According to Stock and Watson (1998) and Napoletano, Roventini and Sapio (2005), co-movements between variables are revealed through the cross-correlation of the cyclical component of each series with the cyclical component of a reference cycle as a benchmark variable (country or a set of countries), which is thought to represent the business cycle. This is the correlation between x_t and y_{t+k}, where x_t is the filtered series and y_{t+k} is the k-quarter lead of the filtered reference variable. A large positive

1 Benazić and Tomić (2014) as well as Demanuele (2017) explained the applicability and relevance of HP filter for the study of business cycle characteristics of the Croatian economy.

correlation at $k = 0$ (i.e. around lag zero) indicates pro-cyclical behavior of the series; a large negative correlation at $k = 0$ indicates counter-cyclical behavior; and no correlation indicates acyclical behavior of the series. A maximum correlation at, for example, $k = -1$ indicates that the cyclical component of the variable tends to lag the aggregate business cycle by one quarter. In other words, if the absolute maximum (or minimum) is achieved at some reference variable lead, then the variable is denoted as *leading*, whereas it is called *lagging* in the opposite case. Finally, *coincident* variables are those displaying the bulk of their cross-correlation with the reference variable at lag zero.

Second, in order to observe and evaluate conclusions from the previous analysis we introduced two concepts of coherence as a part of the *deviation cycle analysis*[2]. The usual interpretation given by scholars to the concept of synchronization between growth and business cycles relates to the pattern of growth between these countries rather than the magnitude of growth rates or the amplitude of the growth trend or business cycles as stated by Crowley and Schultz (2010). By synchronicity we always mean the similarity of movements in growth rates over time, so we have to be careful when we analyze convergence which presents the proximity of growth rates with growth rates of other observed country or unit. Many studies opt to calculate both indicators in order to serve better conclusions. An intensive work by Mink et al. (2007) led to a paper in 2012 which introduced new insight into business cycle coherence by measuring two separate indicators: a) *synchronicity* (φ_{ir}) and b) *similarity* (γ_{ir}). Within their study, coherence of the EU member country i and the benchmark r represented by the enlarging euro area was measured:

$$\varphi_{ir}(t) = \frac{g_i(t)\, g_r(t)}{\left|g_i(t)\, g_r(t)\right|} \tag{2}$$

and

$$\gamma_{ir}(t) = -\frac{n\left|g_i(t) - g_r(t)\right|}{\sum_{i=1}^{n}\left|g_i(t)\right|} \tag{3}$$

where $g_i(t)$ is the cyclical component of the analyzed output of a country i in time t and $g_r(t)$ refers to the cyclical component of the reference country r in time t. When averaged over a time interval and transformed to a uniform scaling, the synchronicity measure shows the fraction of time that the output gap of country i has the same sign as the output gap of the reference cycle, whereas averaging similarity between individual countries and the reference over all n countries in the sample yields co-movement for the region as a whole (Mink et al., 2012). In general, synchronicity between

2 Deviation cycle analysis is concerned with phases of above and below trend rates of growth as it is known also as a growth cycle approach. Alternative measure is viewed as classical cycle approach.

the business cycle of an individual country and the reference cycle ranges between 1 and -1, while for co-movement these values are 1 and 1 - n. As the value is closer to 1, synchronicity and/or similarity is higher. Important feature of this measurement is 'right' reference cycle. Besides considering each one of the new EMU country as a reference variable, we also included *ex post* approach by selecting few more reference cycles that lie closest to Croatia i.e. the median of all EU 28 countries, next EU 15 countries, Germany as a strongest individual economy and off course EMU 19 countries. This would enable us robustness in conclusions.

In the third part, we evaluated Chow test which is the most commonly used to test for the presence of a structural break at a period which can be assumed to be known *a priori*. In this part we opted for two structural breaks. One in 2004:Q2 which is when selected new EMU countries entered the EU, and the other one is 2008:Q3 when the global crisis started. Additionally, we tested for more structural breaks, mainly related to the timing of euro adoption by each county.

3.2. Data

Quarterly data for each country were collected from International Financial Statistics and Eurostat for the period of 1995:Q1- 2014:Q3. Selected new EMU countries are: Cyprus (CYP), Estonia (EST), Latvia (LAT), Lithuania (LIT), Malta (MAL), Slovakia (SVK) and Slovenia (SLO). For additional reference variables we used Germany (GER), EU15, EMU19 and EU28 countries[3]. Data were seasonally adjusted using the Census X12 seasonal adjustment procedure. In order to extract the business cycle component that presents the stationary cycle of the variable we used smoothing parameter λ of 1,600 which is the standard value for quarterly frequencies. To test the integration properties we have analyzed the graphical displays of the variables and applied three unit root tests Augmented Dickey Fuller test (1979), Phillips-Perron test (1988) and Kwiatkowski-Phillips-Schmidt-Shin test (1992); available upon request. Generally, graphs and tests confirmed the absence of a unit root in the observed variables which is an important property of detrended variables. Initial variables included in the evaluation are: unemployment (UNEMP); total number of unemployment, industrial production (IND), debt to GDP ratio (D/GDP), real gross domestic product *per capita* (GDPpc), real gross domestic product index (GDP), imports of goods and services (IMP), exports of goods and services (EXP), consumer price index (CPI) and real effective exchange rate (REER).

3 So far, seven of the twelve countries that joined the EU in 2004 or 2007 have already adopted the euro. Slovenia did so in 2007, Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014 and Lithuania in 2015. Currently, more than 338 million people in 19 EU member countries use the euro. The euro area countries are: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.

3.3. Results

Here are some stylized facts on the business cycle positions (see Table 1.). By interpreting cross-correlations with lags/leads between Croatia and EMU19 we can notice positive i.e. pro-cyclical leading behavior across the selected set of variables. This is important since it suggests that Croatian cycle developments are generally synchronized with the macroeconomic developments within the euro area. Pro-cyclicality suggests that fluctuations first occur within the EMU19 countries and then are transferred into Croatia. Another important point is that most of cross-correlations are statistically significant with coefficients above 0.5 meaning that we trace moderate to strong positive linear relationship across the variables. The only exception is variable unemployment that has shown weak and negative correlation coefficients with lagging pattern. This is nothing strange considering that Croatian labor market is characterized as rigid, inelastic and specific on Phillips-curve reaction (see Basarac (2009) and Benazić and Učkar (2017)). We found some moderate correlation in *t-4* and *t-3* time points and there have been certain signs of latent recovery of employment in Croatia lately (similar to the movements across the whole EU), however this did not encourage us to use this variable in the next phase of the analysis. Considering moderate and strong cross-correlations with a leading pattern, we have chosen next variables for the analysis of synchronization properties, namely industrial production, debt to GDP ratio, gross domestic product, imports and exports.

Table 1.: Cross-correlations; Croatia vs. EMU19

Variables	t-4	t-3	t-2	t-1	0	t+1	t+2	t+3	t+4
UNEMP	**-0,553**	**-0,536**	-0,451	-0,347	-0,276	-0,097	0,088	0,245	0,379
IND	-0,110	0,074	0,282	0,486	**0,565**	**0,533**	0,425	0,236	0,062
D/GDP	-0,172	0,018	0,246	0,440	**0,631**	**0,737**	**0,772**	**0,757**	**0,706**
GDPpc	-0,121	0,058	0,074	0,163	0,284	0,405	0,414	0,400	0,362
GDP	-0,057	0,114	0,341	**0,571**	**0,753**	**0,729**	**0,629**	0,489	0,353
IMP	-0,359	-0,173	0,087	0,371	**0,559**	**0,600**	**0,565**	0,458	0,306
EXP	-0,032	0,111	0,261	0,460	0,602	0,618	0,549	0,352	0,077
CPI	-0,281	-0,115	0,059	0,235	0,392	0,331	0,333	0,234	0,147
REER	0,093	0,193	0,308	0,363	0,395	0,350	0,381	0,346	0,275

Source: Authors' calculation.

Following the methodology presented in Section 3.1., we have calculated two measures of coherence for Croatia, namely the synchronicity and similarity of five assorted variables across different reference cycles and presented them in their graphical form (Figure 1.). Results and figures suggested that synchronicity and similarity levels fluctuated substantially over time, however the similarity seemed to be much less volatile than synchronicity. For example, the average correlation between these two measures over time for the variable industrial production of 0.49 (0.55 with new EMU

countries and 0.37 for selected overall EU reference cycles) illustrates that synchronicity and similarity are in fact two different concepts that tend to change and fluctuate within time domain. Similar results are evident across all other variables. This also means that deviations in business cycles and impact of different shocks have different effects on the pattern and amplitudes of movements in these variables in Croatia, which is indicative for economic policy reasoning also. The overall conclusion is that both coherence measures increased within the analyzed period, however, their positive trend was somewhat different. In general, (1) synchronicity was rather weak in the beginning due to political and economic turmoil in the late 1990s, but as the Stabilization and Association Agreement between the EU and Croatia was signed in 2001, Croatia started achieving a higher degree of synchronization with selected new EMU countries, and the EU in general, especially in industrial production, debt to GDP ratio, national output and imports. Explanation for the rise in business cycle synchronicity can be found in the stronger trade and financial linkages with the EU and the increase in the symmetry of macroeconomic shocks across countries. Crises of 2008 resulted in drastic decline and/or volatility in cycle synchronicity probably due to austerity measures and a decline in general consumption. Weak demand side from the EU and especially new EMU countries could represent a great obstacle for a higher degree of synchronization for Croatia. As the crises was abating, synchronicity started increasing, especially after 2013. On the other hand, (2) similarity for Croatia seemed to be relatively stable over the time with only serious decrease around the EU accession point for the new EMU countries (and with the EU in general), probably due to their last preparations which included trade transaction costs and financial information costs, tendencies towards institutional quality, financial deepening, more flexible labor and product markets etc. After the 2005, similarity measure followed synchronicity measure in trend perspective, which is especially seen following the start of the crisis. Since the similarity measure represents an average co-movement between Croatia and selected reference variable, and we already concluded that we can track positive correlations in trend across different variables, high similarity was in fact expected.

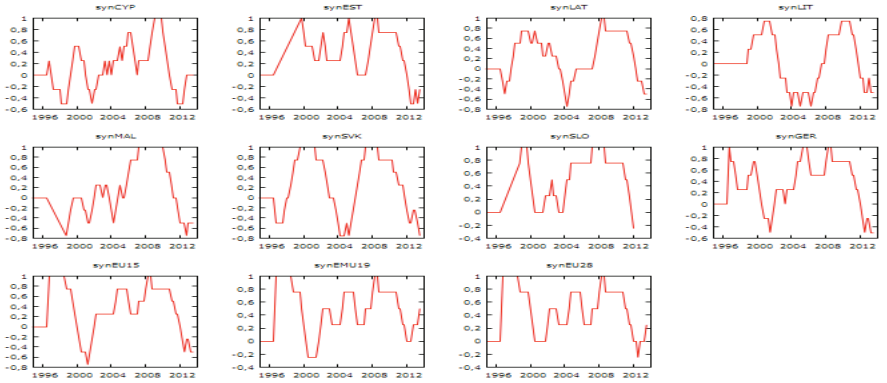
When observing these measures by countries, i.e. different reference cycles, we see almost analogous movements in the synchronicity of Croatia with the new EMU countries and Germany in all five variables, but with slight difference when comparing EU15, EMU19 and EU28 countries. We noticed a minimal divergence in the synchronicity movements when observing Malta and Cyprus compared to other Central and East European countries in all the variables, except the debt to GDP ratio, probably because Croatia traditionally does not have strong economic bonds with those countries. Similar conclusion could be drawn for the similarity measure. We found relatively stable similarity across all the variables with few peaks that are related to the EU accession point and global crisis. Again, the movements in similarity are analogous for most of the countries with some differences when observing Central and East European countries vs. Malta and Cyprus vs. EU15, EMU19 and EU28 countries.

Additionally, we have applied Chow test (see Appendix) for structural breaks to see whether the breaks in time series are analogous as well, which should suggest that we can expect a higher degree of synchronicity and similarity across the variables and countries. We found that most of the structural breaks in 2004:Q2 (EU accession point for the new EMU countries) and 2008:Q3 (start of a global crisis) was within the variables imports and exports across all reference countries, that those breaks are found, but on a smaller scale for the variables industrial production and gross domestic product, and there are almost none of the important structural breaks for the variable debt to GDP ratio. Some of the breaks we found could be related to the monetary union accession point. The absence of odd and inconsistent structural breaks suggested that the coherence of movements across the variables between Croatia and selected countries was relatively stable and thus could provide robust conclusions since they arise from specific empirical points.

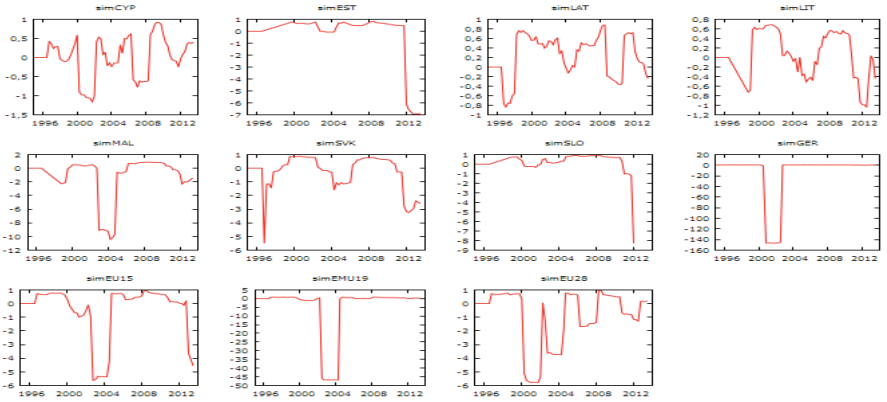
Figure 1.: Coherence measures: all variables across different reference variables

Industrial production (IND)

Synchronicity

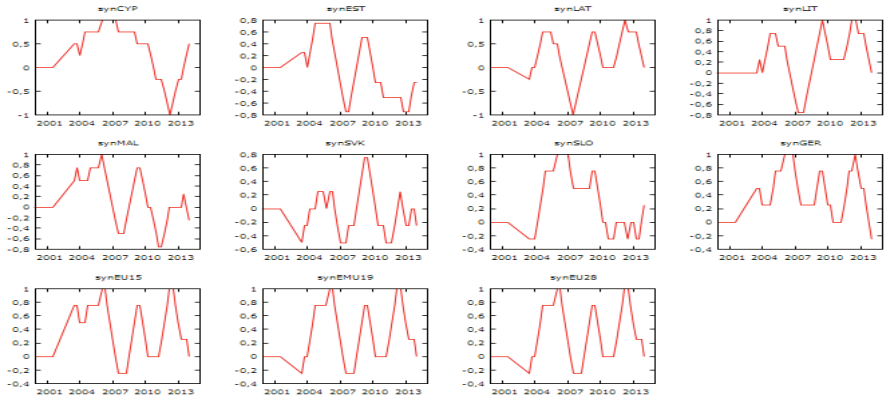


Similarity



Debt to GDP ratio (D/GDP)

Synchronicity



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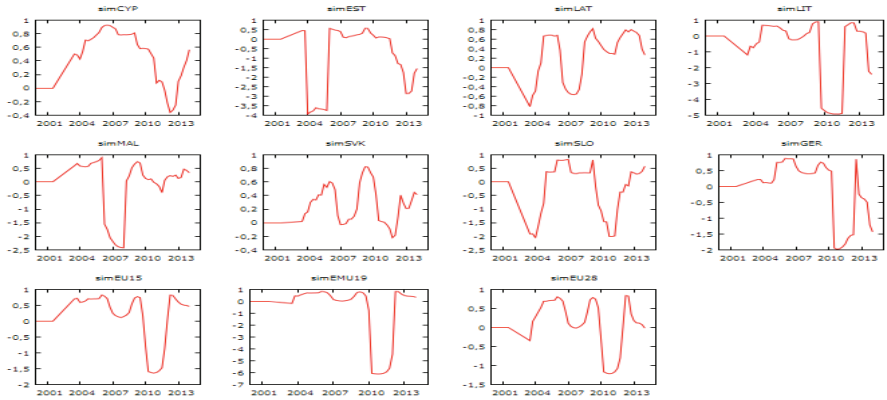
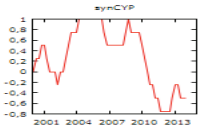
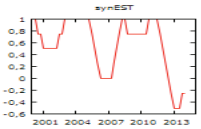
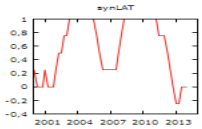


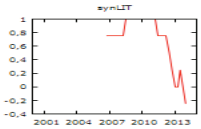
Gross domestic product (GDP)

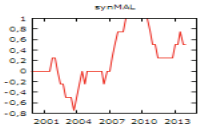
Synchronicity

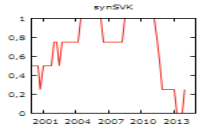


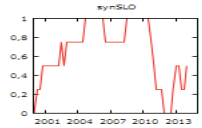


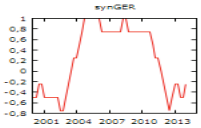


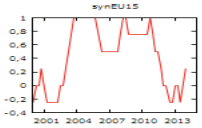


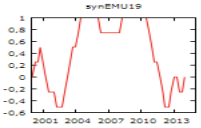


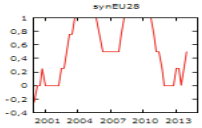












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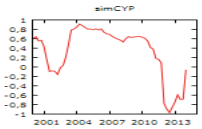
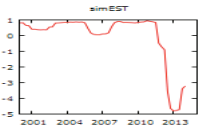
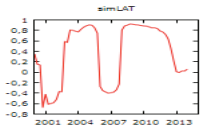
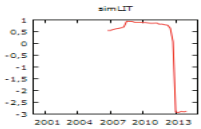
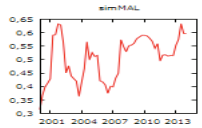
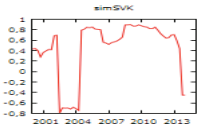


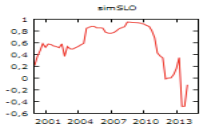


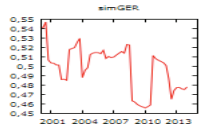


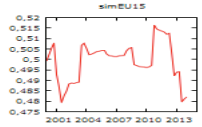


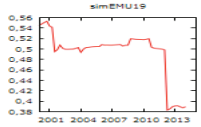


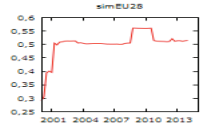






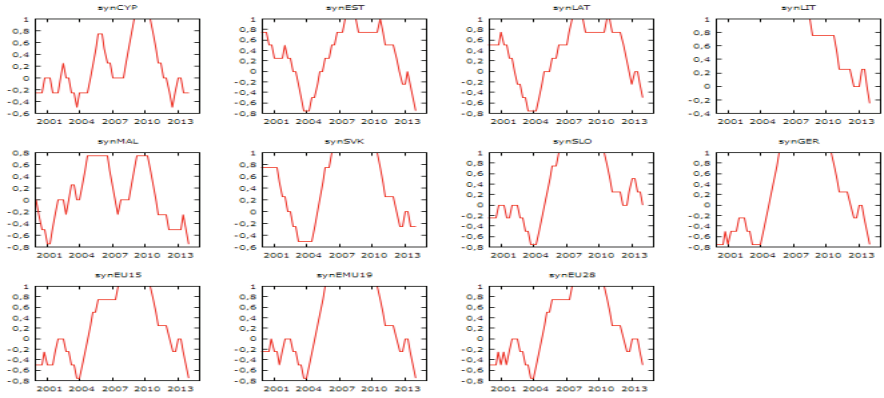






Imports of goods and services

Synchronicity



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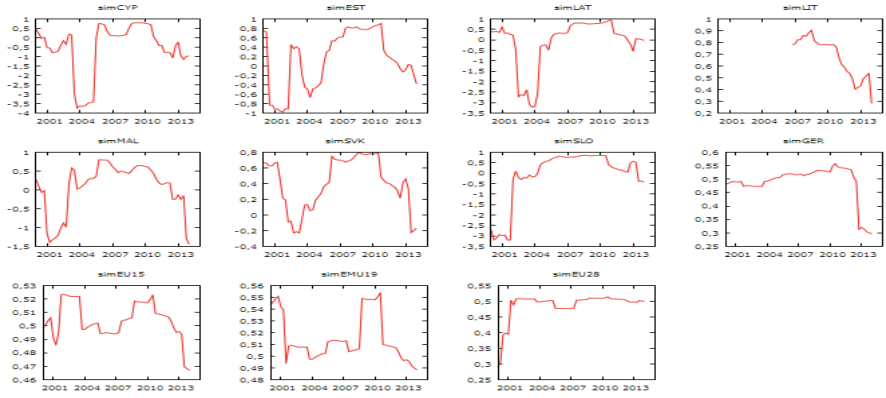
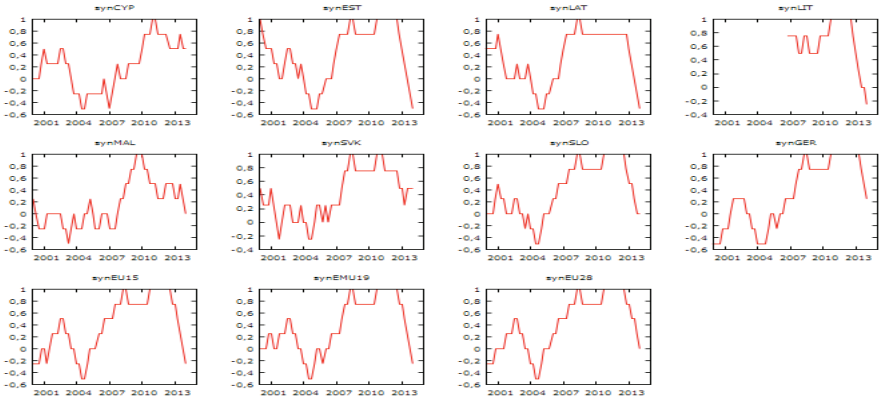


Exports of goods and services

Synchronicity



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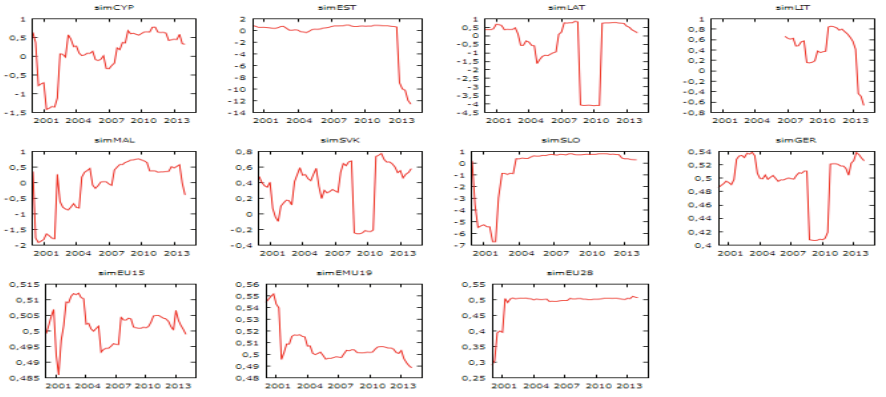

Source: Authors' calculations.

4. A SHORT OVERVIEW OF THE POLICY IMPLICATIONS

Overall results suggest that coherence levels for Croatia fluctuated substantially over time, however, they have a tendency of decreasing with a higher synchronization of the whole EU. The global crisis certainly had a greater negative effect upon the EU business cycle coherence, as synchronicity and similarity decreased likewise in many other Central and East European countries, meaning that the impact of the euro introduction upon the business cycle coherence maybe would not have that desirable stabilization impact. Though we have lately witnessed some de-synchronization processes, the stable monetary policy conducted by the European Central Bank did not amplify the negative trends in business cycle developments in the EU, therefore, it represented a close substitute for national monetary policies. The external environment has significantly worsened recently and will likely remain uncertain for a prolong period of time. Recent events such as Brexit, suggest that access to a large EU market and the political stability factor, while crucial, are not sufficient to achieve country development by itself. Namely, EU membership generates both opportunities and challenges that need to be timely recognized. Aligned economies, i.e. synchronization tendencies are certainly a factor that could assure better development framework.

Our empirical findings indicated a general rise in a synchronicity levels and relatively stable similarity levels for Croatia compared to new EMU countries (and the whole EU and EMU). Hence, if we expect in the future that the implementation of monetary policy in the enlarged EMU is to be more successful if the member countries have synchronized business cycle, the development of co-movements in cycle synchronicity and amplitude of the Croatian economy is of utmost importance for its economic policy. First, although economic shock can be a country specific, a common monetary policy might have asymmetric effects on the countries outside the euro area. Though Croatia manages its own monetary policy and has relatively synchronized economy with the rest of the EU, it is still the question as to what extent its national bank can use exchange rate to effectively stabilize economic activity. So far it has proved to be successful, but this is probably because Croatia is a highly euroized country which monetary reserves come from a strong tourism sector and not from exports. The renewed political uncertainty, coupled with the slow export growth and low investment means that there is no room for ambivalence, hence policy responses must be both immediate and resolute. Unclear responses, both from fiscal and monetary policy, could add to market uncertainty and magnify economic and social tensions. *Ditto*, it indicates that the fast convergence with other EU countries is not an easy process and that the adoption of the euro is not an easy task. At this moment, Croatia does not satisfy the Maastricht criteria, therefore, its monetary policy is limited by the process of fulfilling the criteria and managing national (macro and micro policy) requirements. On the other side, further positive developments on

the demand side in Croatia with optimistic trends on the whole EU market should boost more cooperative international system that will be weighed against the expansion of production capabilities, interaction between consumption and investment, fiscal consolidation, improved quality of life and sustainable development. All that should guide Croatian macroeconomic management to a more comprehensive and pragmatic economic policy goals and decisions.

5. CONCLUSION

Our paper is supplement to the strand of literature that tries to evaluate controversies over business cycle dynamics within the EU, i.e. the compatibility of business cycles and/or coordination of economic policies, as well as it offers constructive analytical commentary. Particularly, we were focused on the question whether Croatia is ready for a deeper degree of economic integration within the EU i.e. common monetary policy. This paper has analyzed the (growth) path of the Croatian economy, comparing it with the cycle dynamics experienced by seven EU countries, namely Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia and Slovenia (plus with Germany and selected EU aggregates such as EU15, EMU19 and EU28), which are the latest countries that have joined the eurozone and thus abandoned their national currency in order to replace it with the euro. First, we have concluded that in this moment Croatia does not entirely comply with the Maastricht requirements. Satisfying the inflation and interest criteria, and by-passing other convergence criteria, primarily the public debt, implies that Croatia still has a long and difficult (formal) way to go before it can become a euro area member. Besides the question of convergence, in order to offer a wider perspective onto the readiness of Croatia for the introduction of the euro, we also introduced the business cycle synchronization analysis. The dynamics of Croatian business cycle is altogether comparable with that of the latest EMU countries. Results in general indicate relatively similar cycle dynamics across the observed variables, suggesting that Croatia satisfies this selective criterion for the inclusion in monetary union. None the less, monetary integration is far more complicated issue, hence it demands further scientific verification and conceptualization. Our deductions as made above are just mere observations and could/should be subject to a revision in the future.

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APPENDIX

Chow test for structural breaks in synchronicity and similarity (Croatia vs. reference country/group of countries) by variables

Reference/ Variable	Synchronicity 2004:Q2	Synchronicity 2008:Q3	Similarity 2004:Q2	Similarity 2008:Q3
	Industrial production (IND)			
Cyprus	F = 0.80 (p = 0.45)	F = 0.52 (p = 0.59)	F = 0.53 (p = 0.59)	F = 2.16 (p = 0.12)
Estonia	F = 1.23 (p = 0.30)	F = 1.30 (p = 0.28)	F = 0.21 (p = 0.80)	F = 1.60 (p = 0.21)
Latvia	F = 0.08 (p = 0.92)	F = 2.35 (p = 0.10)*	F = 0.16 (p = 0.86)	F = 1.83 (p = 0.17)*
Lithuania	F = 0.83 (p = 0.44)	F = 0.78 (p = 0.46)	F = 2.19 (p = 0.12)*	F = 1.61 (p = 0.21)
Malta	F = 2.87 (p = 0.06)	F = 3.06 (p = 0.05)	F = 1.61 (p = 0.21)*	F = 0.04 (p = 0.96)
Slovakia	F = 0.01 (p = 0.99)	F = 2.77 (p = 0.07)	F = 6.23 (p = 0.00)	F = 4.69 (p = 0.01)
Slovenia	F = 1.41 (p = 0.25)*	F = 3.90 (p = 0.03)	F = 5.19 (p = 0.01)	F = 6.44 (p = 0.00)
Germany	F = 2.04 (p = 0.14)	F = 2.29 (p = 0.11)	F = 0.38 (p = 0.68)	F = 0.12 (p = 0.88)
EU15	F = 0.42 (p = 0.66)	F = 1.92 (p = 0.15)	F = 2.13 (p = 0.12)*	F = 0.96 (p = 0.39)
EMU19	F = 0.12 (p = 0.88)	F = 2.22 (p = 0.80)	F = 9.52 (p = 0.00)	F = 0.12 (p = 0.88)
EU28	F = 0.02 (p = 0.98)	F = 0.69 (p = 0.51)	F = 1.66 (p = 0.20)	F = 0.14 (p = 0.87)

* Latvia (2008:Q4) structural break both in synchronicity and similarity; Lithuania (2004:Q1) structural break in similarity; Malta (2004:Q3) structural break in similarity; Slovenia (2004:Q3) structural break in synchronicity; EU15 (2004:Q3) structural break in similarity

Reference/ Variable	Synchronicity 2004:Q2	Synchronicity 2008:Q3	Similarity 2004:Q2	Similarity 2008:Q3
	Debt to GDP ratio (D/GDP)			
Cyprus	F = 0.65 (p = 0.53)	F = 0.70 (p = 0.50)	F = 0.26 (p = 0.77)	F = 1.16 (p = 0.32)
Estonia	F = 0.34 (p = 0.72)	F = 0.04 (p = 0.96)	F = 5.79 (p = 0.00)	F = 0.38 (p = 0.68)
Latvia	F = 0.59 (p = 0.56)	F = 0.91 (p = 0.41)	F = 0.33 (p = 0.72)	F = 2.73 (p = 0.08)
Lithuania	F = 0.89 (p = 0.42)	F = 1.56 (p = 0.22)	F = 0.11 (p = 0.90)	F = 1.09 (p = 0.34)
Malta	F = 0.04 (p = 0.96)	F = 0.24 (p = 0.79)	F = 0.05 (p = 0.95)	F = 0.41 (p = 0.67)*
Slovakia	F = 0.26 (p = 0.77)	F = 0.09 (p = 0.91)*	F = 0.20 (p = 0.84)	F = 0.20 (p = 0.84)
Slovenia	F = 0.36 (p = 0.70)	F = 1.48 (p = 0.24)*	F = 0.94 (p = 0.40)	F = 0.65 (p = 0.53)
Germany	F = 0.47 (p = 0.63)	F = 0.11 (p = 0.89)	F = 0.02 (p = 0.98)	F = 1.58 (p = 0.22)
EU15	F = 0.24 (p = 0.78)	F = 1.50 (p = 0.24)	F = 0.00 (p = 0.99)	F = 0.03 (p = 0.97)
EMU19	F = 0.70 (p = 0.50)	F = 0.62 (p = 0.55)	F = 0.10 (p = 0.90)	F = 0.32 (p = 0.72)
EU28	F = 0.70 (p = 0.50)	F = 0.62 (p = 0.55)	F = 0.89 (p = 0.42)	F = 0.37 (p = 0.70)

* Malta (2008:Q1) structural break in similarity; Slovakia (2009:Q4) structural break in synchronicity; Slovenia (2007:Q2) structural break in synchronicity

Reference/ Variable	Synchronicity 2004:Q2	Synchronicity 2008:Q3	Similarity 2004:Q2	Similarity 2008:Q3
	Gross domestic product (GDP)			
Cyprus	F = 1.54 (p = 0.22)	F = 2.02 (p = 0.14)*	F = 0.22 (p = 0.80)	F = 0.62 (p = 0.52)
Estonia	F = 0.65 (p = 0.53)	F = 1.32 (p = 0.27)*	F = 0.33 (p = 0.72)	F = 1.35 (p = 0.27)*
Latvia	F = 1.00 (p = 0.37)	F = 1.38 (p = 0.26)	F = 0.03 (p = 0.97)	F = 0.47 (p = 0.63)
Lithuania	/	F = 0.49 (p = 0.49)	/	F = 0.22 (p = 0.80)
Malta	F = 2.57 (p = 0.08)*	F = 0.08 (p = 0.92)	F = 0.32 (p = 0.72)	F = 1.14 (p = 0.32)
Slovakia	F = 1.85 (p = 0.17)	F = 1.45 (p = 0.25)	F = 2.99 (p = 0.06)	F = 0.87 (p = 0.42)
Slovenia	F = 2.04 (p = 0.14)	F = 1.83 (p = 0.17)*	F = 1.56 (p = 0.22)	F = 1.81 (p = 0.17)
Germany	F = 0.19 (p = 0.82)	F = 2.80 (p = 0.07)	F = 0.64 (p = 0.53)	F = 3.94 (p = 0.03)
EU15	F = 1.32 (p = 0.27)	F = 1.36 (p = 0.64)	F = 0.19 (p = 0.83)	F = 0.21 (p = 0.81)
EMU19	F = 0.19 (p = 0.83)	F = 1.37 (p = 0.26)	F = 0.23 (p = 0.80)	F = 1.08 (p = 0.35)
EU28	F = 0.99 (p = 0.38)	F = 0.87 (p = 0.43)	F = 0.33 (p = 0.72)	F = 0.71 (p = 0.50)

* Cyprus (2008:Q4) structural break in synchronicity; Estonia (2011:Q1) structural break both in synchronicity and similarity; Malta (2006:7) structural break in synchronicity; Slovenia (2008:Q4) structural break in synchronicity

Reference/ Variable	Synchronicity 2004:Q2	Synchronicity 2008:Q3	Similarity 2004:Q2	Similarity 2008:Q3
	Imports of goods and services (IMP)			
Cyprus	F = 1.68 (p = 0.20)	F = 0.64 (p = 0.14)*	F = 1.60 (p = 0.21)	F = 0.18 (p = 0.83)
Estonia	F = 2.16 (p = 0.12)*	F = 1.98 (p = 0.15)*	F = 5.40 (p = 0.01)	F = 0.51 (p = 0.60)
Latvia	F = 2.61 (p = 0.08)	F = 1.63 (p = 0.21)*	F = 10.32 (p = 0.00)	F = 0.04 (p = 0.96)
Lithuania	/	F = 1.18 (p = 0.29)	/	F = 1.11 (p = 0.34)
Malta	F = 0.68 (p = 0.51)	F = 0.52 (p = 0.60)	F = 2.05 (p = 0.14)	F = 1.38 (p = 0.26)
Slovakia	F = 2.75 (p = 0.07)	F = 1.18 (p = 0.31)	F = 0.69 (p = 0.51)	F = 0.51 (p = 0.61)
Slovenia	F = 2.87 (p = 0.07)	F = 1.37 (p = 0.26)	F = 0.12 (p = 0.88)	F = 0.23 (p = 0.80)
Germany	F = 1.31 (p = 0.28)	F = 5.29 (p = 0.01)	F = 0.37 (p = 0.69)	F = 1.34 (p = 0.27)
EU15	F = 0.83 (p = 0.44)	F = 4.45 (p = 0.02)	F = 2.04 (p = 0.14)	F = 2.16 (p = 0.12)
EMU19	F = 0.93 (p = 0.40)	F = 3.85 (p = 0.03)	F = 0.24 (p = 0.79)	F = 0.26 (p = 0.77)
EU28	F = 1.72 (p = 0.19)	F = 2.83 (p = 0.07)	F = 0.29 (p = 0.75)	F = 0.12 (p = 0.89)

* Cyprus (2005:Q1) structural break in similarity; Estonia (2004:Q1, 2011:Q1) structural break in synchronicity; Latvia (2014:Q1) structural break in synchronicity

Reference/ Variable	Synchronicity 2004:Q2	Synchronicity 2008:Q3	Similarity 2004:Q2	Similarity 2008:Q3
	Exports of goods and services (EXP)			
Cyprus	F = 0.46 (p = 0.64)	F = 2.40 (p = 1.00)*	F = 1.88 (p = 0.16)	F = 1.61 (p = 0.21)
Estonia	F = 3.58 (p = 0.04)	F = 3.67 (p = 0.03)	F = 0.16 (p = 0.85)	F = 1.06 (p = 0.35)*
Latvia	F = 1.15 (p = 0.32)	F = 4.04 (p = 0.02)	F = 0.47 (p = 0.63)	F = 0.56 (p = 0.58)
Lithuania	/	F = 1.61 (p = 0.22)	/	F = 0.17 (p = 0.85)
Malta	F = 3.67 (p = 0.03)	F = 3.84 (p = 0.03)	F = 12.81 (p = 0.00)	F = 0.98 (p = 0.38)
Slovakia	F = 4.23 (p = 0.02)	F = 0.52 (p = 0.60)	F = 0.09 (p = 0.91)	F = 0.05 (p = 0.95)
Slovenia	F = 2.29 (p = 0.11)	F = 0.82 (p = 0.44)	F = 1.60 (p = 0.21)	F = 0.12 (p = 0.89)
Germany	F = 1.28 (p = 0.28)	F = 0.64 (p = 0.51)	F = 0.19 (p = 0.83)	F = 0.22 (p = 0.79)
EU15	F = 0.95 (p = 0.39)	F = 3.15 (p = 0.05)	F = 0.77 (p = 0.47)	F = 0.11 (p = 0.90)
EMU19	F = 0.81 (p = 0.45)	F = 2.71 (p = 0.08)	F = 0.85 (p = 0.43)	F = 0.47 (p = 0.63)
EU28	F = 0.83 (p = 0.43)	F = 1.51 (p = 0.23)	F = 0.02 (p = 0.98)	F = 0.01 (p = 0.99)

* Cyprus (2008:Q4) structural break in synchronicity; Estonia (2011:Q1) structural break in similarity; Malta (2008:Q1) structural break in synchronicity

Source: Authors' calculations.